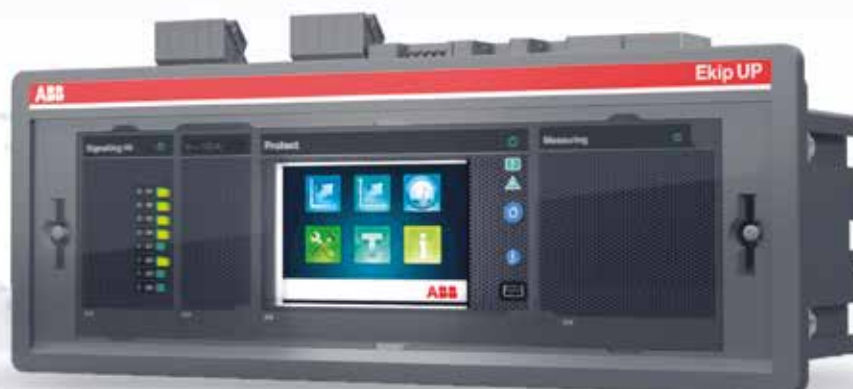


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LOW VOLTAGE

# Technical specifications

## for low voltage digital unit



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**The goal of this specification is to define the basic design requirements of digital unit for low voltage installations with rated voltage up to 1150V AC and rated current up to 6300A. It shall enable easy update installations, providing monitoring, protection and control functions. The current document describes the general aspects of the unit, such as conformity with Standards, functional, environmental and construction characteristics and a list of the accessories available.**

# General Characteristics-Conformity with Standards

Digital unit used in low voltage installations shall be constructed and tested in accordance with international IEC 60255 and UL 508 series of Standards:

- **IEC 60255-26** (ECM requirement), **IEC 61000-6-2** (EMC-Immunity Standard) and **IEC 61000-6-4** (emission standard)
- **IEC 61010-1** (General requirement)
- **UL 508** (Standard for Industrial Control Equipment)
- **DNV-GL** (type approval certificate)
- **RINA** (type approval certificate).

In addition it shall respect the following directives:

- CE "Low Voltage Directives" (LVD) 2014/35/EU
- CE "Electromagnetic Compatibility Directive" (EMC) 2014/30/EU
- UL and cULus.

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# Environmental characteristics

## Temperature:

- Operating temperature for unit and accessories: -25 °C ...+60 °C
- Storage temperature: -40°C .... +70°C

## Environmental parameters:

Unit shall be able to operate in particularly difficult industrial atmospheres. It shall have been tested in accordance with:

- **IEC 60068-2-1**: dry cold climate
- **IEC 60068-2-2**: dry hot climate
- **IEC 60068-2-30**: humid hot climate

## Protection degree:

shall be not less than IP40

## Vibrations:

Unit shall comply with the following mechanical compatibility standards and classes.

- **IEC 60255-21 class 1** (vibrations, shocks and blows), with DIN guide assembly
- **IEC 60255-21 class 2** (vibrations, shocks and blows), with door assembly.

# Functional characteristics

It shall be possible to connect directly the digital unit in network with phase to phase voltage up to 690V. It shall be possible to connect digital unit with external transformers to enable installation of device in network with rated service voltage up to 1150 V AC.

- Rated current shall be between 100 and 6300 A with the possibility of set trip threshold of L protection from 40A;
- Digital unit shall be suitable for installation with rated frequency 50 Hz or 60 Hz.
- Different versions of digital unit shall be available, according to monitoring, protection and control functions required. According to model selected, it shall be possible to upgrade unit with advanced functions.
- Digital unit shall provide supervision functions to monitor main energy parameters and power quality, either locally or on cloud energy monitoring system, without requiring external unit for communication or gateway.
- Datalogger shall ensure information on trigger events for fast diagnosis in case of fault or anomalies.
- Digital unit shall be suitable for protection based on current and voltage measurement.
- Digital unit shall be provided with specific protection for generators.
- Digital unit shall be provided with algorithm to enable optimization of energy consumption of plant and with communication to enable Demand response functions.
- Self-diagnosis functions shall be always available to check continuity of internal connection of unit and with sensors, pre-alarm and alarm for abnormal temperature, to guaranty correct operation.

# Construction characteristics

- Digital unit shall be designed to be door or DIN-rail mounted.
- Digital unit shall be designed with orientable digital contacts to enable mounting on DIN rail or on the front door of the switchboard.
- Labels for wiring connection shall be visible in each mounting solution allowed.
- Serial Number shall be printed on side face of unit case, it shall be visible from front display, and from remote through commissioning software.
- Unit shall be provided with software for commissioning, analysis of fault and testing of communication bus.
- Terminals for current sensors shall be provided either for 3 poles and 4 poles installations.
- Rogowski coil current sensors shall be provided to enable flexibility, linearity and easy detection of quickly current variations as well as harmonic contents.
- Closed current sensor with copper terminals for busbar up to 4000A shall be available to allow installation in switchboards with reduced space.
- Closed current sensors shall be available in version without copper terminals for cable connections for current up to 2500A.
- Opening Rogowski coils up to 6300A, not requiring auxiliary power supply, shall be provided also for upgrade of existing switchgears.
- Terminal box shall be with spring clamps.
- It shall be possible to install the electrical accessories without removing the cover.
- Dedicated slot for power supply module.
- Device unique serial number shall be visible on sticker, available on the touchscreen menu and also remotely readable via data communication.
- Warranty shall be available for 1 year with extension up to 5 years.

# Accessories

The following accessories shall be available for the whole range:

- Digital unit shall be provided with plug-in on board power supply unit.
- Remote control and signaling shall be possible through digital I/O freely configurable. It shall be possible to add additional I/O modules for 2, 4 or 10 more digital I/O. It shall be possible to connect at the same time up to three external digital I/O module for 11 input and 10 output with one unit by local bus.
- It shall be possible to connect 3 or 6 temperature inputs and 1 or 2 analogic 4-20mA inputs.
- It shall be possible to adjust the rated current of digital unit by applying at the front part suitable plug.
- It shall be possible to upgrade basic measuring functions, enabling measurement of phase and neutral voltages, powers and energy, through additional plug-in measuring module.

When required following accessories shall be available:

- Unit shall be supplied homopolar toroid for earth conductor (star center of the transformer), with rated current from 100 to 800 A.
- Relay shall be supplied with homopolar toroid for residual current protection to enable monitoring of earth current from 3...30 A.
- Unit shall be supplied with accessory to measure voltages from two phases of one line through an external transformer for check of synchronization of parallel lines. Module shall be provided with output contact that is activated when synchronism condition is verified.

# Protection Functions

## Measurement functions

- Digital unit shall be provided with measurement of the currents flowing in the three phases and in the neutral.
- Accuracy of the ammeter measurement shall be equal or better than 0,5% and 1% when connected to current sensors; current ranges between 20% - 120% of  $I_n$  (range referred to IEC 61577-12)
- Unit shall be able to provide measurement of the voltages (phase-to-phase, phase-to-ground). Accuracy of the voltage measurement chain shall be equal or better than 0,5% and 0,7%, when connected to sensors.
- Unit shall be able to provide measurement of powers and energies (active, reactive, apparent). Accuracy of the measurement chain shall be equal or better than 1% and 2% including accuracy of sensors.
- Set of measurement functions that shall be available on the protection release:
  - Current measurements
  - Voltage measurements
  - Power measurements
  - Power factor measurements.
  - Measurements of frequency and peak factor
  - Phase Sequence
  - Energy measurements
- Digital unit shall record minimum and maximum values of phase currents, voltage in range of time settable between 5 and 120 minutes.
- Digital unit shall record maximum and average values of active and reactive power, in range of time settable between 5 and 120 minutes.

## Power Quality functions

- Digital unit shall be able to provide measurement according to IEC 61000-4-30 Ed. 2
- and EN50160 standards of the main power quality gauges, like:
  - Voltage spikes
  - Voltage sags
  - Voltage micro-interruptions
  - Harmonic analysis (voltage harmonics, current harmonics, THD) up to the 50th harmonic
- Data logger with 2 independent registers shall be available to record current, voltages and active power. Sampling frequency shall be settable in a range from a minimum of 1200Hz up to 9600Hz.
- Digital unit, when associated with switching device, shall be able to register and store information about:
  - Number of operations (mechanical and electrical)
  - Load profile
  - Last maintenance carried out
- Time stamp shall be always available and shall store information of last 200 events with associated time stamps.



Instantaneous	<p>Currents (L1, L2, L3, N, rms)  Earth fault current (rms)  L-L voltage (V12, V23, V31, rms)  L-N voltage (V1, V2, V3, rms)  Phase sequence  Frequency (Hz)  Active power (P1, P2, P3, Ptot)  Reactive power (Q1, Q2, Q3, Qtot)  Apparent power (S1, S2, S3, Stot)  Power factor (cos-phi)  Peak factor (L1, L2, L3, N)</p>
Cumulative measurement	<p>Active power Ep (tot, + and -)  Reactive power Eq (tot, + and -)  Apparent power Es (tot)</p>
Network analyzer	<p>Average volts/hour (Vmin= 0.75-0.95 xVn, Vmax= 1.05-1.25 xVn, Events/day in past year and total events)  Short voltage interruptions  Short voltage spikes, sags and swells  Voltage unbalance and micro-interruptions  Harmonics analysis (THDv, THDi, V/I up to 50th order)  2 independent registers for V/I/P with sampling frequency user-settable from 1200 to 9600Hz</p>
Time-stamped values	<p>Currents (Imin, Imax)  L-L voltage (Vmin, Vmax)  Reactive power (Qmean, Qmax)  Apparent power (Smean, Smax)  Time-stamp of last 200 events</p>
Data logging	<p>Currents (L1, L2, L3, N, Ig)  Voltages (V12, V23, V31)  Active power (Pmean, Pmax)  Max recorded duration  Recording stop delay  Recording intervals = 5 to 120 min, user-settable</p>
Trip and opening data/info	<p>Type of protection on trip  Fault values per phase based on trigger (see note below)  Time-stamping (date, time, progressive number)</p>
Maintenance indicators	<p>Last 30 trips info (see note below)  Last 200 events info (time-stamped)  Mechanical operations (can be sent to alarm)  Total number of trips (see note below)  Total operating time (hours)  Last maintenance performed (date)  Maintenance required indication  Unit ID (type, assigned name and serial number)</p>
Self-diagnosis	<p>Internal connections checks  CB failure to open (ANSI 50BF) (see note below)  Over-temperature (pre-alarm and alarm)</p>

# Protection Functions

## Basic Protection functions

- Adjustable protection against overload (L), with a delay up to 144s (with  $I=3I_n$ ), L protection shall be excludable;
- Digital unit shall have Inverse definite minimum time (IDMT) operating curves in accordance with IEC 60255-151, supporting both IEC and ANSI/IEEE standard.
- $I^2t$  equal to constant curve shall be available for better coordination with upstream switching devices or fuses.
- A settable pre-alarm on overload shall be available.
- Protection against short circuit, selective (S) shall always be adjustable, with a delay up to 0.8s, and a pick-up threshold ranging from 0.6 to 10 times  $I_n$ .
- Protection against short circuit, instantaneous (I) shall be settable with several pick-up thresholds, up to 15 times  $I_n$ .
- It shall be possible to enable overcurrent protection of neutral and set up to 200% of phase currents.
- Protection against ground fault (G) shall be settable with several pick-up thresholds, ranging from 0.1 to 1 times  $I_n$ .
- For G protection, a pre-alarm indication with settable threshold shall be available and it shall be possible to exclude trip, keeping only alarm for continuity of service.
- Protection functions against short circuit and ground fault shall be excludable.
- It shall be possible to connect digital unit with external toroid for ground fault protection.

## Advanced protection functions:

- Thermal memory for functions L and S shall be available;
- Start-up function shall be available for protections S, I and G, to avoid trips due to inrush current during the “start-up” of motors or transformers;
- Second complete set of parameters for protections shall be stored in the unit and activated by means of a digital input, communication network, unit display or started automatically after a set time.
- Protection against unbalanced current or unbalanced voltage shall be provided by digital unit
- Embedded additional protections, based on voltage/frequency measurement shall be available:
  - Under voltage protection (UV)
  - Over voltage protection (OV)
  - Under frequency protection (UF)
  - Over frequency protection (OF)
- Shall be possible to enable second protection against under voltage, overvoltage, over frequency and under frequency.
- It shall be possible to activate residual current function by using dedicated accessory and external toroid.

### **Additional Generator Protection**

- Unit shall have comprehensive voltage protection functions including:
  - Residual overvoltage (59N)
  - Cyclical direction of phases (47)
  - Three-phase voltage-dependent overcurrent protection (51V) against short circuit close to generator terminals. Function shall operate when current exceeds a set value calculated on measured terminal voltage. It shall be possible to select either a voltage restrained/ voltage slope or voltage controlled/voltage step characteristics.
- To protect generator against harmful effects of excessive overpower, digital unit shall have protection against reverse active power (32R)
- Unit shall have under excitation protection (/40/32R) to protect synchronous machine against loss of field or reverse reactive power conditions, that can cause excessive heating on stator winding.
- Digital Selectivity
  - It shall be possible to lock overcurrent and ground fault protection to enable fast fault isolation, while guarantying continuity of service in healthy part of installation.
  - It shall be possible to use logic selectivity with directional overcurrent protection to enable selectivity in ring distribution system.
- Directional overcurrent
  - Digital unit shall provide directional protection with two different time-delay according to current direction.
- Restricted / unrestricted earth
  - It shall be possible to connect external unit with digital unit for restricted earth fault, distinguishing it from a non-restricted earth fault.
- Synchrocheck
  - Function shall include energizing check functionality and support the operation mode dead-line / live-line. The function shall ensure that the voltage, phase angle and frequency on two separate sections of networks meet requirements for safe interconnection.

### **Additional Logics**

- Load Shedding
  - Load shedding function shall be available to avoid frequency drop in off-grid state that might cause generation protections trip.
  - It shall be possible to upgrade basic load shedding function to adaptive logic to disconnect not priority loads according to power consumption and frequency.
- Interface protection
  - Digital unit shall have embedded logic functions to disconnected local generation from the grid whenever voltage and frequency values of the grid itself are out of the ranges prescribed by the standard, in order to avoid feeding of failure on grid.
  - Interface protection function shall be certified for CEI 0-16 standard.
- Power Controller
  - Digital unit shall manage active/passive loads by embedded software, sending command from remote to relevant switching devices according to a user default priority.
  - Embedded algorithm shall be able to foresee average power absorption calculation which can be set over a determined time interval; whenever this forecasted value and to compare it with contractual power, in case value is over contractual power it shall operate turning off/or the devices under control, to stay beyond limits.
  - It shall be possible to define weekly scheduling and to take into consideration tariff bands for maximum saving on billing.
  - It shall be possible to control up to 15 loads or group of loads.
- Predictive maintenance
  - It shall be possible to enable predictive maintenance in the cloud with ABB circuit breakers or switch-disconnectors.

# Protection Functions

ANSI Code	Short description
49	Overload Protection, excludable, delay to 144 at 3xIn, with thermal memory
50TD	Time-delayed overcurrent protection, time delay up to 0.8s, settable 0.6 to 10xIn, excludable, with thermal memory and provision to offset inrush
50	Instantaneous overcurrent protection, settable up to 15xIn, with provision to offset inrush currents
50N TD	Earth fault protection, settable 0.1 to 1xIn, excludable, with provision to offset inrush currents
46	Current unbalance protection
50	Instantaneous overcurrent protection
	Closing on short-circuit protection
50G TD	Earth fault protection
64 50N	Residual current protection
TD87N	Differential ground fault protection
	Current threshold LC
	Current threshold Iw
27	Undervoltage Protection
59	Overvoltage Protection
47	Voltage unbalance protection
81L	Underfrequency protection
81H	Over-frequency protection
32R	Reverse active power protection
47	Cyclical direction of phases
78	3-phase power factor (cos-phi)
50TD	Time-delayed overcurrent protection
67	Directional overcurrent protection (forward and back)
27	Undervoltage Protection
59	Overvoltage protection
81L	Underfrequency protection
81H	Overfrequency protection
51V	Voltage controlled overcurrent protection
59N	Residual overvoltage protection
32OF	Active overpower protection
32OF	Reactive overpower protection
32LF	Active underpower protection
40/32R	Loss of field or reverse reactive power protection
51V	Voltage controlled overcurrent protection
81R	Rate of change of frequency protection
25	Synchrocheck (Live busbars)

## User interface and HMI

- Digital unit shall have high resolution display for monitoring and controlling. Each alarm or warning shall be clearly shown on the display.
- Access to control and configuration of the unit shall be allowed by means of a password;
- It shall be possible to set as default page of the display to show measure or logics.
- 4 digital input/output, 8 analog inputs for current and voltage signals shall be available on digital unit.
- Full colour touchscreen for readouts and menu access.

## Communication (wired)

- It shall be possible to connect digital unit, through communication bus twisted pair or Ethernet, with one or more communication protocols at the same time without external interface devices, choosing among:
  - Modbus RS485
  - Modbus TCP
  - Ethernet IP
  - DeviceNet
  - Profibus
  - Profinet
  - IEC 61850
- To guarantee the maximum safety, a redundant communication profile shall be provided.
- To ensure a redundant communication layer (for example local/system) shall be possible to install up to four different communication modules
- Proprietary communication bus should also be available for easy integration of power automation logics.
- It shall be possible to store data on cloud by using gateway embedded module.
- Communication module with certified cybersecurity shall be available to exchange data-reports with load aggregators and utilities.







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